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Understanding the Impacts of Trauma on Child Development:

Implications for Child Serving Systems

Joyce L. Calland

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Executive Summary

Lawmakers in Ohio are becoming increasingly concerned with the number of youth in the Ohio Department of Youth Services facilities (youth corrections) who have mental illness and trauma histories. Recent Ohio legislation has been introduced that will require an interagency effort to select and implement a trauma screening tool that will be used in child-serving systems including: Department of Youth Services, the Department of Medicaid, the Department of Job and Family Services, the Department of Health, and the Department of Mental Health and Addiction Services. The purpose will be to utilize this trauma information in improving services and outcomes for children.

This paper reviews the literature related to trauma and how it impacts human development. Birth to three is a time of rapid brain development in a person's life and it is when experiences are shaping the organizing brain. Traumatic experiences in those years are particularly concerning for health and well-being through-out life. Past studies have taken a retrospective approach in determining the effects of trauma. In other words, these past studies have analyzed traumas that have been substantiated or self-reported with people who are already experiencing the effects through poor health outcomes or risky behaviors. Taking a prospective approach and using data from Ohio's Help Me Grow- Home Visiting Program, the research question for this paper is; does caregiver stress impact the developing young child? The hypothesis is that when a caregiver is experiencing high amounts of stress, there is an increased risk of developmental delays in children.

A logistic regression was used in this study to determine the odds of caregiver stress impacting the development of young children. The results from this study suggest that caregivers that report stress are more likely to have children at risk for fine and gross motor delays in children under the age of three. These findings are consistent with research on the development of the brain. There was no significant difference in risk of delay in other areas of child development.

With this information, the policy alternatives are numerous. While there is no single theoretical framework that captures all that is involved in human development, understanding the impacts of trauma through a developmental lens is critical. In selecting trauma assessment instruments, we must also discover the history of the individual and understand when in the developmental life of a person these traumatic events occurred. Assessing this information within all the child serving systems, will help us to intervene as early as possible and in more appropriate ways. We must also continue to front load services like Help Me Grow and high quality child care, as this is the time in life that policy makers can get the most return on investment. In the long run, these strategies could make huge strides in reducing the number of children whose behaviors, resulting from traumatic experiences, move them in the juvenile justice system.

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Introduction

In 2011, Ohio House Bill 86 came into effect and required an Interagency Task Force on Mental Health and Juvenile Justice to be formed. The purpose of this task force was to investigate and make recommendations on how to most effectively treat delinquent youth who suffer from serious mental illness or emotional behavioral disorders. This Ohio Interagency Task Force report found that a "significant number of youth with trauma histories come into contact with the juvenile justice system and the Ohio Department of Youth Services" (Ohio Interagency Task Force on Mental Health and Juvenile Justice, 2012, p2). The report goes on to say that these youth typically have known severe emotional disturbances and histories of multiple system involvement. Yet, the mental health needs of these youth either go unaddressed or are addressed inadequately at the community level before the youth come into contact with the juvenile justice system. The report states that it is critical to recognize how trauma impacts the onset of symptoms and responsiveness to treatment (Ohio Interagency Task Force on Mental Health and Juvenile Justice, 2012).

Research shows that up to 34 percent of children in the United States have experienced at least one traumatic event, however for youth in the juvenile justice system the rate is between 75 and 93 percent (Adams, 2010). The Surgeon General's 2002 Report on Children's Mental Health stated that the prevalence of mental health disorders among youth in the juvenile justice system is three times higher than that among youth in the general population (Ohio Interagency Task Force on Mental Health and Juvenile Justice, 2012). It would seem that mentally ill youth are being funneled into the juvenile justice system. This is a very costly intervention for the state of Ohio, and more importantly, it can be further damaging to the youth.

On February 13, 2013 Ohio House Bill 59, which is Ohio's State Fiscal Year 2014/2015 Biennial Budget Bill, was introduced and included language requiring The Office of Health Transformation to convene a cross-agency team to evaluate the feasibility of implementing a trauma screening tool for high-risk youth.[1] While it seems to be clear among policy makers that screening for trauma histories is needed, we must go a step further and investigate when in the developmental life of a person these traumatic events occurred. These are two key pieces of information that will help to select appropriate interventions.

There is an ongoing tension, of where to spend Ohio's scarce resources, between prevention and treatment programs aimed at improving outcomes for youth. Unfortunately, and due to the crisis nature of children who need government interventions, most funding is directed towards high need youth. This study does not support one end of this continuum (prevention to treatment) over the other. The aim of this research is to convey that at either end of the service continuum we need to understand how trauma and/or stress has or will impact the developing brain of the child.

The stakeholders who are concerned about the effects of trauma include families and child serving systems such as: education, health care- including mental health, alcohol and drug addiction, child welfare, and juvenile justice systems. The child serving systems exist on a

[1] Under Section 501.10, Page 4157- The Office of Health Transformation shall convene a team comprised of the Department of Youth Services, the Department of Medicaid, the Department of Job and Family Services, the Department of Health, and the Department of Mental Health and Addiction Services. The team shall evaluate the feasibility of implementing a trauma screening tool for high-risk youth and create a report with the following information: (A) the recommended trauma screening tool to be used to evaluate high-risk youth; (B) training in the administration of the recommended tool; (C) screening protocols; (D) the persons to whom the recommended tool should apply; and (E) the implications for treatment. The report shall be completed by December 1, 2013, and shall be distributed to the Governor. The Department of Youth Services may receive funds for piloting the recommended tool in detention centers.

continuum of care from prevention through treatment, and they serve children across the age continuum. They differ in their responsibilities for meeting children's needs, however, they all strive to improve outcomes for children (Ko, Ford, Kassam-Adams, Berkowitz, Wilson, Wong, 2008). The term of providing "trauma informed care" is not yet well defined among child serving systems. Some agencies have engaged in assessing trauma histories of children/youth, however no apparent concerted effort across child serving systems has occurred. Children with trauma histories can experience psychobiological alterations in their development. This can increase their risk of low academic performance and lead to engagement in high-risk behaviors (Ko, Ford, Kassam-Adams, Berkowitz, Wilson, Wong, 2008). Systems must understand and appropriately intervene with these children who have trauma histories. In addition, this intervention must occur at the earliest point of discovery. Intervening as traumatic stress becomes known can have a significant impact on children's lives and perhaps reduce the number of these youth who seem to be funneled into the juvenile justice system. It also has the potential to save funding.

This study will present the literature on the impact of trauma in early childhood and show that early childhood is a critical time to prevent trauma from having lifelong impact. Much of the past research and data that has been collected on trauma histories has been conducted in a retrospective fashion with children or adults who have had substantiated cases or self-reported trauma. The purpose of this paper is to take a prospective approach in analyzing the effects of parental stress on early childhood development. Specifically, does caregiver stress impact the developing young child? This approach was chosen to see if the impacts of traumatic stress begin to manifest and can be identified as they are occurring. This study will examine data collected through Ohio's Help Me Grow program on young children and will include measures of current child development and caregiver stress. It is hypothesized that, as high amounts of

stress are found in caregivers, risk for delays in child development will also be found. Finally, as the term of providing "trauma informed care" is a current buzz phrase in service systems, the paper will conclude with policy recommendations for integrating knowledge of the developmental impact of trauma into services for children.

Literature

The literature reviewed explores how stress and trauma have lifelong impacts on people. There is research that demonstrates the developmental impacts of stress and trauma on children. In addition, one study has found links between trauma histories and the leading causes of death in adults. In each of the studies reviewed, trauma connections are explored with individuals already experiencing the ill effects.

The home is the most violent place in America (Perry, 2001). In one study of children aged 2-5, more than half (52.5 percent) had experienced a severe stressor in their lifetime. The most common traumatic stressors for young children include: accidents, physical trauma, abuse, neglect, and exposure to domestic and community violence (NCTSN, 2013). Young children may witness the assault of their caregiver or be the direct victim of violence (Perry, 2001). One study estimated that 3 million couples per year engage in severe violence towards each other (Lieberman, Knorr, 2007).

In reviewing the literature, the words stress and trauma are often used interchangeably. All people experience stress in their daily lives as a moderate reaction to an unsafe reality. Trauma actually occurs when the nervous system is overwhelmed and cannot act against a perceived threat. Trauma can be real or perceived and it can develop as a result of one event or repeated exposure to traumatic stressors. An experience can be fine for one child and

overwhelming for another. In short, stress and trauma exist on a continuum (The Israel Center for the Treatment of Psychotrauma, 2012). In May 2012, the Substance Abuse and Mental Health Services Administration (SAMSHA) convened a team who developed a working definition of trauma:

> *Individual trauma results from an event, series of events, or set of circumstances that is experienced by an individual as physically or emotionally harmful or threatening and that has lasting adverse effects on the individual's functioning and physical, social, emotional, or spiritual well-being.(SAMSHA: Justice and Trauma, 2012)*

Historically, people believed that children were resilient through these experiences and, in fact, minimized how these events might impact the developing child (Perry, 2001).

During the first three years of a child's life, the brain develops to 90 percent of adult size and lays the foundation for all future emotional, behavioral, social and physiological functioning needed for life (Perry, 2001). If the body developed at the same rate as the brain, toddlers would be five or six-feet tall (Perry & Szalavitz, 2010). This underlines the importance of the first three years of life. When a child is exposed to violence, it activates a set of threat-responses in the child's developing brain. When this exposure results in persisting fear and excess activation, it can actually alter the development of the child's brain. The organizing and sensitive brain of a young child is shaped more by experiences than that of a mature brain. In fact, a persisting state of fear actually causes dysregulation of functions in the child's brain stem and midbrain systems that later become traits in the child (Perry, 2001). Although people don't have conscious memories of infancy, a baby's early experiences are imprinted into their brain (Perry & Szalavitz, 2010). The brain is organized in a hierarchical fashion from the bottom up: brainstem (least complex and least changeable), diencephalon, limbic system, and cortex (most complex and most changeable). The very same traumatic event will impact an 18-month old child differently than a 5-year old (Perry, 2009). In order to most efficiently influence a higher

function such as speech and language or socio-emotional communication, the lower functions of the brain must be well regulated. Even in adults, threat or distress shifts control away from rational, abstract thinking to lower regions of the brain responsible for rapid action allowing a person to fight or flee (Perry & Szalavitz, 2010).

Humans and animals use two primary response patterns to perceived threat; hyperarousal (fight or flight) and dissociation. Dissociation is a broad descriptive term of a mental mechanism that involves disengaging from the external world and attending to stimuli in the internal world. These two response patterns are interactive and most people use combinations during any traumatic event. Generally, the primary patterns seem to shift from dissociation to fight or flight during development. When children perceive threat, their brain will orchestrate a total-body mobilization to adapt to the situation. In an infant, crying is how a hyperarousal response would be exhibited. Crying is successful if the caretaker comes and fights or flees with the child, but if not and after many disappointments, the child will abandon that behavior and will move along the dissociative continuum. This dissociation or "surrender" response can include distraction, avoidance, numbing, and, in extreme situations even fainting or a catatonic state (Perry, 2001).

The effects of neglect have been highlighted in cases found in Romanian orphanages. Studies of the children that were warehoused in large orphanages, with just minimal care and social interaction, have found that many of the orphans had smaller brains than typically developed children of the same age. They also had significant developmental delays in language and fine and large motor development (Zeanah, 2009). In addition, studies of neglect have been associated with reduced size of the brain cortex. This area is responsible for many complex functions including memory, attention, perceptual awareness, thinking, language, and

consciousness (NCTSN, 2013). And, as previously noted, it is much harder to use these higher systems of the brain when you are in distress.

The Bucharest Early Intervention Project was the first-ever randomized controlled trial of foster care as an alternative to institutional care that was conducted in Bucharest, Romania. This study included 136 children aged 6-31 months who were placed in institutions (mostly at birth) and 72 typically developing Romanian children. The children being raised in institutions had substantial delays in almost every area of development as compared to the typical children. Following the initial assessment, the 136 children from institutions were randomly assigned to either continued institutional care or to foster care that was of high quality. The results were consistent in that the foster care children had more favorable outcomes than those who remained in institutional care. However, the children were never able to attain the level of development of those who had never been institutionalized. In addition, there were several sensitive periods in several domains of development. For example, in language, those placed at 15 months in foster care had almost full recovery of language functioning. However, those placed after 24 months had no response to the intervention as measured up to 54 months. In summary, early experiences can cause significant effects on development and it appears that not all can be completely recovered (Zeanah, 2009).

The bond between a young child and their caregiver facilitates the healthy physical, emotional, and cognitive development of the child. Bonding is the process of forming an attachment and includes a set of behaviors that lead to this emotional connection. Infants are defenseless and rely on their caregiver for survival. The acts of holding, rocking, singing, feeding, kissing and nurturing are bonding experiences for a young child (Perry, 2001). These positive interactions help to regulate the stress response system (Perry & Szalavitz, 2010). In

addition, healthy relationships that protect and heal, can actually help to build resilience in coping with trauma. However, individuals who have few to no positive relational interactions during or after trauma or stress have a much more difficult time decreasing the stress response systems in future activations and will be more likely to have ongoing difficulties (Perry, 2009). A child who has been emotionally neglected can display profound attachment problems that are difficult to change in any improved experiences later in life (Perry, 2001). If the caregiving adult is impacted similarly by the trauma, that makes it additionally difficult for the child. The very same neurodevelopmental sensitivity that allows a young child to advance in response to predictable, nurturing, repetitive, and enriching experiences makes the child vulnerable to adverse experiences (Perry, 2009). Both frightening and frightened behavior by a caretaker are linked to disorganized attachment in young children. Failure to develop a secure attachment in infancy appears to have far-reaching impact throughout an individual's life resulting in difficulties with relationships and regulation of emotions and impulses (Putnam, 2006).

Stress itself is not all bad. Learning involves small doses of stress, because it requires something new and unfamiliar (Perry & Szalavitz, 2010). So, activating the stress response networks in small amounts actually strengthens these networks over time. It is the large and irregular activations that can interfere with development. We must also note that no stress can be as bad as too much. Moderation and rhythm are key elements in developing healthy stress response systems (Perry & Szalavitz,2010).

Dr. Bruce D. Perry and the Child Trauma Academy of Houston have taken what is known about developmental neurobiology into a practical clinical approach with maltreated children. This model called the Neurosequential Model of Thereapeutics (NMT), has been used in clinical settings for approximately 20 years. This practice has three elements: collection of a

developmental history, a current assessment of functioning, and results in a set of recommendations for intervention and enrichment that arise from the process. They are actually able to "map" the brain of an individual. The developmental status of a child in various domains is pictured: For example, a 10-year old child may have the speech and language capability of an 8-year old, the social skills of a 5-year old, and the self-regulation skills of a 2-year old (Perry, 2009). NMT has been used in clinical settings and is getting promising results. This model considers how past traumas have impacted the brain and translates that into interventions that are making a difference.

The Adverse Childhood Experiences (ACE) Study, conducted in 1996 and 1997, demonstrated a link between specific stressors and future risky behaviors and health problems in adulthood. The ACE study was a collaborative study between the Centers for Disease Control and Prevention and Kaiser Permanente's Health Appraisal Clinic in San Diego, and they studied over 17,000 adults. They investigated the participants past traumas, current behaviors and health statuses (Middlebrooks, 2008). These histories were strongly associated with the leading causes of death including heart disease, cancer, diabetes, liver disease and emphysema. In the study, the ACE score was the total number of ACEs that each study participant reported. For example, experiencing physical abuse would be an ACE score of 1. As the number of ACEs a person experiences increases, the risk for the poor health outcomes also increases. A Logistic regression analysis was used to find a strong graded relationship between the breadth of exposure to abuse or household dysfunction during childhood and multiple risk factors for the above described leading causes of death in adult life (Felitti et al., 1998).

While much research has been done on the developing brain, past research on the impacts of trauma have been done retrospectively with children and adults with known trauma histories.

The data collected in this study comes from Ohio's Help Me Grow program, a program aimed at the prevention end of the continuum. This report will analyze the current impact of parenting stress collected through the Parenting Stress Index© on the current developmental progress of the child, age birth through two years of age, collected via the Ages and Stages Questionnaire©. Similar to the ACE study, it is hypothesized that as high caregiver stress is found, there will be increased risk of delayed development in the child.

Data

The purpose of this study is to take a prospective approach in analyzing the effects of early childhood stress on child development. As previously described, past studies have been done in retrospective fashion, that is after trauma and/or stress have been substantiated or self-reported, then analyzed later in a person's life. The approach for this study was chosen to see if the impacts of traumatic stress begin to manifest and can be identified as they are occurring.

Children ages zero to three are unable to verbally report traumatic stress, so self-report data of caregiver stress will be compared to measures of their child's current development. The data examined in this study were extracted from the Ohio Department of Health's Early Track database in December of 2012. Early Track collects data from participants in Ohio's Help Me Grow (HMG) Home Visiting program, which serves first time caregivers who have a child less than three years of age. The data used for this research include the initial stress and child development data collected at entry to the HMG program. The Ohio Department of Health provided a de-identified data file of 11,860 children, however only 5,671 of those contained data on both measures needed for this study. Univariate descriptive statistics about each of the variables in this study can be found in table 1 on the next page.

Table 1- Descriptive Statistics					
Variables	**Observations**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Record ID #	5671	6679.063	2846.658	1	13411
Female- 1 Male-0	5671	.4835126	.4997722	0	1
White – 1 All other-0	5671	.6279316	.4833991	0	1
Black -1 All other-0	5671	.2860166	.4519371	0	1
Other-1 All other-0	5671	.0860518	.2804653	0	1
Caregiver Mother-1 Other-0	5671	.9195909	.2719495	0	1
Target Criteria-1 Alternate-0	5671	.707459	.4549695	0	1
High Stress-1 Moderate to no stress-0	5671	.1347205	.3414549	0	1
Developmental Age- tool used	5671	5.535884	5.616624	2	36
Gross Motor Domain	5671	.0366778	.1879862	0	1
Fine Motor Domain	5671	.0239817	.1530055	0	1
Personal-Social Domain	5671	.0218656	.1462576	0	1
Communication Domain	5671	.0167519	.1283518	0	1
Problem-solving Domain	5671	.0243343	.1540985	0	1

Dependent Variables

Change in Child Development. The child development data are collected by the HMG home visitor via caregiver self-reporting using the Ages and Stages Questionnaire© (ASQ). The ASQ is a valid and reliable instrument with 21 questionnaires that can be used with children

from one month through five and a half years of age.[2] (Ages & Stages, 2013). This tool screens infants and young children for risk of developmental delays in five developmental areas: gross motor, fine motor, personal-social, communication, and problem-solving.[3] For this study, data were collected for children up to 36 months of age upon program entry. Each area of development is a dependent variable that was examined. According to the chart in Appendix A, each developmental area is scored and contains cutoffs that indicate any existence of risk for developmental delay at two standard deviations from the mean for each age group (Ages & Stages, 2013). Each child that scored below the mean score in a developmental domain for his/her age is considered to potentially developmentally delayed. A dummy variable was used and those that scored as delayed were coded as 1, and those that were not were coded as 0.

Independent Variables

Parenting Stress. Parenting stress data are also collected by the home visitor in the HMG program via caregiver self-report using the Parenting Stress Index Short Form© (PSI-SF). The primary caregiver completes the form which takes about 10 minutes to complete. The PSI-SF is a validated 36-item questionnaire that is designed to identify potentially dysfunctional parent-child systems. It contains a Total Stress Score, which is the sum of three sub-scale scores that are individually scored: Parental Distress, Difficult Child Characteristics, and Dysfunctional Parent-Child Interaction (People Virginia, 2013). The Total Score is the independent variable for this

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[2] Questionairres are available at any or all of the following intervals: 2, 4, 6, 8, 9, 10, 12, 14, 16, 18, 20, 22, 24, 27, 30, 33, 36, 42, 48, 54 and 60 months of age.

[3] Developmental Domains- Gross motor development is how children use their limbs and hands to explore their environment. Fine motor development is how children use their fingers to grasp and hold objects in their environment. Personal-social development is the child's emerging development of understanding of self and others, and the ability to relate to other people and the environment. Communication development is the increasing ability to connect successfully with others to build relationships, share meaning and express needs in multiple ways. Problem-solving development involves the building of thinking skills (OCCRA, 2013).

study. A total stress score measures the stresses the caregiver is experiencing in his/her role as a parent. A score is considered to be high at a cutoff of 91 or above. Again, a dummy variable was used and those at or above that cutoff were coded as 1 and those below were coded 0.

Several variables were held constant that have the potential to impact developmental delays. Each of the developmental areas was analyzed separately, while controlling for the other areas of development. In addition, dummy variables were created to control for sex (female 1 and male 0), race as "white" (1 or not 0) "black" (1 or not 0) or "other" (1 or not 0), the type of caregiver as either "mother" (1) or "other" (0), and if the child qualified for the program under the "target criteria" (1) or "alternate criteria" (0).[4] A Correlation Matrix for the variables can be seen in Appendix C.

Methods

A predictive analysis using a non-experimental, binary simple logistic regression was conducted. A logistic regression model was chosen to predict the binomial categorical outcome

[4] Home Visiting- Target Criteria:(a) Families consisting of first-time mothers and their child, when the infant is not yet six months of age at the time of system referral, with a family income not in excess of two hundred percent of federal poverty level; or (b) Families consisting of expectant, first-time mothers with a family income not in excess of two hundred percent of federal poverty level and the infant upon live birth. Alternate Criteria: (a) Families consisting of an expectant first-time mother; (b) Families consisting of a first-time mother with an infant or toddler under three years of age;(c) Families consisting of a first-time father with an infant or toddler under three years of age;(d) Families consisting of an infant under six months old at the time of system referral and a birth or biological mother, biological or adoptive father, or an individual acting in place of a birth, biological or adoptive parent, such as a grandparent, stepparent, or other relative, with whom the child lives; (e) Families consisting of an expectant mother or parent with an infant or toddler under three years of age who provide documentation of a family income not in excess of two hundred percent of federal poverty level; (f) Families with a child under three years of age being referred to home visiting as identified on form HEA 8021, effective July 1, 2012; or (g) Families consisting of an expectant mother or a birth, biological or adoptive parent who is in the U.S. military and their infant or toddler under three years of age (Ohio HMG, 2013).

of developmental delay in each domain (either delayed or not delayed). Specifically, the model was chosen to predict the odds of being at-risk of delay in each of the five developmental domains based on the categorical stress data as the predictor. The regression coefficients were estimated using maximum likelihood estimation. The confidence interval set for this study was that used as the standard practice interval of 95 percent. The null hypothesis, that the probability risk of a developmental delay is not attributable to caregiver stress, was rejected at a p-value of 0.05 in each regression equation.

Limitations

This study is relying on the powerful relationship between a child and caregiver to explore how traumatic stress may impact child development. The literature explains that it is how an event or series of events are experienced by an individual that determines if they are traumatic. Two individuals can interpret an event very differently. In this case, the experience for the child and the caregiver could be very different.

Results

As previously stated, the hypothesis of this study is that high stress levels exhibited in a child's caregiver will increase the likelihood of children being at-risk for developmental delay. A logistic regression was used to calculate the log odds ratio of stress on each of the child developmental domains. The Likelihood Chi-2 test is statistically significant, which indicates that in each of the five models, the group of variables as a whole is a significant predictor of risk for each type of delay. The Stata output tables for each logistic regression can be found in Appendix B. A summary of the regression analysis can be found in table 2 on the next page.

Table 2- Logistic Regression Odds- Ratios on Five Developmental Domains

Variables	Gross Motor	Fine Motor	Personal-Social	Communication	Problem-Solving
Parent Stress	**1.553 ***	**1.630***	.980	1.230	1.093
	(.303)	**(1.239)**	(.289)	(.365)	(.297)
Female	.751	.870	.831	**.637***	1.139
	(.114)	(.168)	(.177)	**(.148)**	(.226)
White	**2.840***	.830	1.269	3.490	1.699
	(1.123)	(.304)	(.609)	(2.534)	(.811)
Black	1.990	1.004	1.393	2.076	1.540
	(.824)	(.387)	(.698)	(1.575)	(.772)
Mother	.594	1.396	.795	1.200	.623
	(.173)	(.503)	(.275)	(.428)	(.191)
Target Criteria	1.165	.850	.711	**.572***	.685
	(.247)	(.207)	(.188)	**(.158)**	(.172)
Child's age	**.898***	**1.031***	1.000	**1.052***	1.003
	(.022)	**(.016)**	(.019)	**(.0163)**	(.018)
Commun-ication	1.280	**3.431***	**7.465***	—	**5.160***
	(.480)	**(1.174)**	**(2.471)**		**(1.732)**
Gross Motor	—	**4.554***	**7.781***	1.264	**3.498***
		(1.240)	**(2.040)**	(.503)	**(1.007)**
Fine Motor	**4.793***	—	**3.413***	**2.940***	**8.903***
	(1.315)		**(1.099)**	**(1.088)**	**(2.497)**
Problem-solving	**3.290***	**8.934***	**10.219***	**5.443***	—
	(.996)	**(2.448)**	**(2.834)**	**(1.861)**	
Personal-social	**7.864***	**3.378***	—	**7.165***	**10.180***
	(2.086)	**(1.067)**		**(2.524)**	**(2.860)**
LR $Chi2^2$	**244.56***	**261.16***	**340.38***	**212.9***	**347.96***
Pseudo R^2	.1371	.2035	.2852	.2205	.2680
	* indicates p-value < 0.05 (standard errors are in parentheses)				

Gross Motor

The null hypothesis can be rejected, as there is support for the hypothesis in gross motor development. Holding all other things constant, the findings in the domain of gross motor were determined to be significant at a 95 percent confidence interval. The odds ratio on parent stress is 1.55, indicating that when a caregiver is experiencing high stress, the odds of the child being at-risk of a gross motor delay is 55 percent more likely than if the caregiver is not experiencing

high stress. According to the literature, gross motor development is a result of functions in the Diencephalon/Cerebellum region of the brain. This low area in the brain is one that is becoming well developed by the age of three and is the area to develop after the brainstem (Perry, 2013). The regression also shows that children who are white are almost three times more likely to be at-risk for a gross motor delay. In addition, being at-risk of fine motor, personal-social, and problem-solving delays have a positive relationship with risk for a gross motor delay.

Fine Motor

The null hypothesis can be rejected, as there is support for the hypothesis in fine motor development. Holding all other things constant, the findings on the domain of fine motor were also determined to be significant at a 95 percent confidence interval. The odds ratio on parent stress is 1.63, indicating that when a caregiver is experiencing high stress, the odds for risk of a fine motor delay is 63 percent more likely than if the caregiver is not experiencing high stress. Fine Motor development is also a result of functions in the Diencephalon/Cerebellum region of the brain. Being at-risk of gross motor, personal-social, communication, and problem-solving delays have a positive relationship with risk for a fine motor delay.

Personal-social

The support for the hypothesis in personal-social development was not supported, at a 95 percent confidence interval, therefore the null hypothesis cannot be rejected. This is not surprising, according to the literature, as the understanding of self and others and the ability to relate to other people and the environment is a dynamic process involving all areas of the brain and mostly the limbic and cortex areas. These areas of the brain are the last to develop respectively in the hierarchy of brain development. However, the regression did show that being

at-risk of gross motor, fine motor, communication, and problem-solving delays have a positive relationship with risk for a personal-social delay.

Communication

The support for the hypothesis in communication was not supported, at a 95 percent confidence interval, therefore the null hypothesis cannot be rejected. This finding is also not surprising, as according to the literature, communication development is a result of functions in the cortex regions of the brain. This area of the brain is one that fully develops last in the hierarchy of development, is the area most easy to change, yet it is the most complex region of the brain (Perry, 2013). The regression did show that females are less likely to be at-risk for a communication delay. Also, that those who qualified for HMG through the target criterion were less likely to be at-risk for a communication delay. Being at-risk for fine motor, personal-social, and problem-solving delays have a positive relationship with risk for a communication delay.

Problem-Solving

The support for the hypothesis in problem-solving was also not supported, at a 95 percent confidence interval, therefore the null hypothesis cannot be rejected. Just as with developing communication, developing thinking skills are functions of the cortex area of the brain, a much more pliable outer area of the brain that is the last to develop in the hierarchy (Perry, 2013). The regression does show that being at-risk for gross motor, fine motor, personal-social and communication delays have a positive relationship with risk for a problem-solving delay.

Conclusions

The results of this study are consistent with the research of the way that the brain develops. The areas of motor development that were found to be statistically significant, with

regard to caregiver stress as a predictor, reinforce the developmental framework of the brain. The Brainstem and the Diencephalon/Cerebellum regions develop first in the hierarchy of brain development and the brainstem is the one involved in a body's stress response. The average age of children in this study is 5.5 months with the mode being 5.6 months of age. So, it is not surprising that stress shows up as a predicator for risk of motor delays in children in this study (Perry, 2013).

There is no single theoretical framework that captures all that is involved with human development. For example, any congenital conditions have not been factored into this study. And, literature reveals that two individuals can interpret a traumatically stressful event very differently. In this case, the experience for the child and the caregiver could be very different. Therefore, an area for future research may be to select a method to more strongly assess the young child's direct experience of traumatic stress. Dr. Bruce Perry has been doing some research within the education system where they are using pulse oximeters in the classroom for students to detect their own stress (Perry, 2013). For future studies, using a pulse oximeter with babies may be a better indication of detecting traumatic stress. Still, the findings of this study are applicable across the age spectrum of children.

This study not only demonstrates the impact of traumatic stress on development, but it aligns with the research on brain development. If systems understand when trauma occurred within a child's brain development, this should assist in knowing how to more appropriately intervene. Knowledge of brain development should complement, but not replace other frames of reference. The brain is the most complex organ of the body. It is an open and dynamic set of systems (Perry 2013). In the search to become trauma informed systems-of-care, it is evident that we must understand and work with the knowledge of the biological development of the brain. It

is important to appropriately assess any traumas that have impacted children, and it is equally important to know at what age these traumas occurred. The brain's Cortex is the easiest part of the brain to change, however all information is processed from low in the brain and on up. If a child is dysregulated low in the brain, likely from trauma in early childhood, they cannot properly access their Cortex. The goal of an educator, for example, is to get to the Cortex. A dysregulated stress response system can "derail" the information from ever reaching this part of the brain. In fact, a child in a dysregulated state of high arousal can only process about 50 percent of what a child who is regulated (Perry, 2013). This is very important to know as we plan services for children, particularly those who have experienced trauma in their lives.

One other factor that seems important to highlight is that this study also emphasizes the power of the caregiver and child relationship. The literature reveals that healthy relationships can help to build resilience in coping with trauma. In designing treatment plans, it seems the caregiver and other primary relationships are important factors to be considered throughout life.

Policy Recommendations

While this paper is not intending to emphasize where to spend limited public resources in services to families and children. There is clear evidence that prevention programs like HMG should be supported, as the majority of all brain development occurs before the age of three. From the literature, this is also the easiest time in life to change the brain. An economist and Nobel laureate, James Heckman, found that a quality preschool program can provide $7 to $12 return for every $1 invested (Heckman, et.al., 2010).

From the literature, it seems that you can change the brain at any age. However, it becomes more difficult to do as a person grows and develops and those lower functions of the brain become well formed. The fact remains that there are mentally ill youth who have

experienced trauma and who have a substantial need for services. So, there are several policy options to be considered.

Child-serving systems could continue to serve children/youth without investigating their trauma histories. However, the volume of youth with whom are experiencing major illnesses (mentally and physically) and end up in the juvenile justice systems would not likely decrease. The treatment they are being given may not be as effective without addressing the underlying issues. For example, a child may not be able to benefit from traditional therapies (e.g. Cognitive Behavioral Therapy-CBT), if their past traumatic experiences in early childhood have resulted in their inability to regulate their response system in stressful situations. In this situation, a child/youth may not be able to access the higher functioning structures of the brain that are once again needed for cognitive processing. In this instance CBT may not be as effective and would be more costly to use with less than desired results. Working to first regulate the child before trying a treatment like (CBT) may get better results.

Another policy alternative might be that each child serving system decides on their own how to assess a child for past traumatic experiences. However, for youth that are being served by multiple systems, continuity of care may be a challenge. Also, if they do not also consider the developmental age at which these experiences occurred, opportunities to appropriately intervene may be hindered.

In collaboration, it is recommended that child-serving systems work together to select a short list of assessment tools and procedures found to be valid and reliable for particular use in the field. The National Child Traumatic Stress Network has compiled a database of reviews of tools that measure children's experiences of trauma, their reactions to it, and other mental health and trauma-related issues. This valuable information paired with the knowledge of when the

trauma occurred in the development of the child, would seem to be the two powerful pieces of information that would improve the treatment of high-need children.

Finally, holistically systems could become better informed about the developmental impacts of trauma and work to imbed this information in practices across the prevention/intervention and age continuums. This would seem to have the biggest fiscal and human impact, as systems intervene when information on the child's history becomes known. It seems clear, that understanding brain development is a key element in knowing how to intervene with children who have or are at-risk of experiencing trauma.

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Appendix A-Ages & Stages Questionnaire Cutoffs Per Age Group

Developmental Domain	*Tool*	2 mo	4 mo	6 mo	8 mo	9 mo	10 mo	12 mo	14 mo	16 mo	18 mo	20 mo	22 mo	24 mo	27 mo	30 mo	33 mo	36 mo
Communication	ASQ2		33.0	29.0	36.7		25.0	15.8	31.0	34.5	23.0	36.3	35.0	36.5	33.5	38.8	35.0	38.7
Gross Motor	ASQ2		40.1	19.5	24.3		17.5	18.0	24.0	32.3	41.5	36.2	25.0	36.0	35.0	30.6	41.5	35.7
Fine Motor	ASQ2		27.5	27.5	36.8		39.0	28.4	25.0	30.6	39.5	39.8	25.0	36.4	26.0	25.2	29.5	30.7
Problem Solving	ASQ2		35.0	37.0	32.3		30.5	25.2	28.5	26.9	33.0	29.9	25.0	32.9	37.0	28.9	36.5	38.6
Personal-social	ASQ2		33.0	27.5	30.5		30.0	20.1	22.5	26.7	37.0	35.2	25.0	35.6	33.0	36.9	36.0	38.7
Communication	ASQ3	22.77	34.6	29.65	33.06	13.97	22.87	15.64	17.4	16.81	13.06	20.50	13.04	25.17	24.02	33.30	25.36	30.99
Gross Motor	ASQ3	41.84	38.41	22.25	30.61	17.82	30.07	21.49	25.8	37.91	37.38	39.89	27.75	38.07	28.01	36.14	34.80	36.99
Fine Motor	ASQ3	30.16	29.62	25.14	40.15	31.32	37.97	34.50	23.06	31.98	34.32	36.05	29.61	35.16	18.42	19.25	12.28	18.07
Problem Solving	ASQ3	24.62	34.98	27.72	36.17	28.72	32.51	27.32	22.56	30.51	25.74	28.84	29.30	29.78	27.62	27.08	26.92	30.29
Personal-social	ASQ3	33.71	33.16	25.34	35.84	18.91	27.25	21.73	23.18	26.43	27.19	33.36	30.07	31.54	25.31	32.01	28.96	35.33

Appendix B- Regression Analysis by Domain

Gross Motor Development- Dep Variable
Logistic Regression

Log likelihood = -769.42114

Number of observations = 5671
LR chi2 (11) = 244.56
Prob > chi2 =0.0000
Pseudo R2 =0.1371

Indep Var	Odds Ratio	Standard Error	z	P>|z|	[95% Conf.	Interval]
Stress	1.553013	.3025378	2.26	0.024	1.06012	2.275072
Sex	.7506281	.1143651	-1.88	0.060	.5568477	1.011843
White	2.84021	1.123314	2.64	0.008	1.308268	6.166007
Black	1.990423	.8241589	1.66	0.096	.8840871	4.481215
Other	1	(omitted)				
Caregiver	.593849	.173036	-1.79	0.074	.3354691	1.051234
Target/Alt	1.165357	.2465171	0.72	0.469	.7698353	1.764089
Dev Age	.8978587	.0220834	-4.38	0.000	.8556028	.9422016
Fine Motor	4.792812	1.314597	5.71	0.000	2.799746	
Pers-Soc	7.863798	2.086061	7.77	0.000	4.675528	13.22617
Communic	1.279783	.4804125	0.66	0.511	.6132069	2.670948
Prob-Solve	3.289812	.9555398	4.10	0.000	1.861812	5.813078
_cons	.028266	.0136236	-7.40	0.000	.0109902	.0726983

Fine Motor Development- Dep Variable
Logistic Regression

Log likelihood = -511.11924

Number of observations = 5671
LR chi2 (11) = 261.16
Prob > chi2 =0.0000
Pseudo R2 =0.2035

Indep Var	Odds Ratio	Standard Error	z	P>|z|	[95% Conf.	Interval]
Stress	1.630166	.3873202	2.06	0.000	2.671831	7.763083
Sex	.8698932	.1676528	-0.72	0.470	.5962323	1.26916
White	.8300817	.3042881	-0.51	0.611	.4046604	1.70275
Black	1.003994	.3874085	0.01	0.992	.4712814	2.138858
Other	1	(omitted)				
Caregiver	1.395886	.5034618	0.92	0.355	.6884027	2.830463
Target/Alt	.8497658	.2071623	-0.67	0.504	.5269713	1.370287
Dev Age	1.030932	.0163116	1.93	0.054	.9994523	1.063403
Gross Mtr	4.5543	1.239229	5.57	0.000	2.671831	7.763083
Pers-Soc	3.378452	1.066523	3.86	0.000	1.819731	6.272323
Communic	3.430505	1.174494	3.60	0.000	1.753615	6.710917
Prob-Solve	8.933685	2.447737	7.99	0.000	5.22168	15.28449
_cons	.0104735	.0054231	-8.80	0.000	.0037962	.0288959

Personal-Social Development- Dep Variable | **Number of observations = 5671**
Logistic Regression | **LR chi2 (11) = 340.38**
Prob > chi2 =0.0000
Log likelihood = -426.47695 | **Pseudo R2 =0.2852**

Indep Var	Odds Ratio	Standard Error	z	P>|z|	[95% Conf.	Interval]
Stress	.9795966	.288818	-0.07	0.944	.5496478	1.745863
Sex	.8311864	.1774425	-0.87	0.386	.5469947	1.26303
White	1.268151	.6092324	-0.49	0.621	.4945902	3.251597
Black	1.393131	.6981805	0.66	0.508	.5216805	3.720313
Other	1	(omitted)				
Caregiver	.7953114	.2750845	-0.66	0.508	.4037581	1.566582
Target/Alt	.7106575	.1876205	-1.29	0.196	.4235794	1.192301
Dev Age	.9997786	.0187753	-0.01	0.991	.9636486	1.037263
Gross Mtr	7.780569	2.039935	7.83	0.000	4.654151	13.00715
Fine Motor	3.412571	1.098907	3.81	0.000	1.815432	6.414801
Communic	7.464622	2.471321	6.07	0.000	3.901212	14.28289
Prob-Solve	10.21871	2.83412	8.38	0.000	5.933602	17.59841
_cons	.0131137	.0076458	-7.43	0.000	.0041825	.0411158

Communication Development- Dep Variable | **Number of observations = 5671**
Logistic Regression | **LR chi2 (11) = 212.90**
Prob > chi2 =0.0000
Log likelihood = -376.22986 | **Pseudo R2 =0.2205**

Indep Var	Odds Ratio	Standard Error	z	P>|z|	[95% Conf.	Interval]
Stress	1.230318	.3652312	0.70	0.485	.6875917	2.201428
Sex	.6371572	.1483996	-1.94	0.053	.40364	1.005771
White	3.4902	2.533721	1.72	0.085	.8412364	14.48047
Black	2.076201	1.575457	0.96	0.336	.4692054	9.187045
Other	1	(omitted)				
Caregiver	1.199748	.4276538	0.51	0.609	.5965908	2.4127
Target/Alt	.5721122	.1579817	-2.02	0.043	.332991	.9829467
Dev Age	1.051861	.0162974	3.26	0.001	1.020399	1.084293
Gross Mtr	1.264367	.5029157	0.59	0.555	.5798271	2.75707
Fine Motor	2.940623	1.088463	2.91	0.004	1.423541	6.074479
Prob-Solve	5.44287	1.861373	4.95	0.000	2.784395	10.63959
Pers-Soc	7.16552	2.524453	5.59	0.000	3.592234	14.29324
_cons	.0034531	.002804	-6.98	0.000	.0007031	.0169596

Appendix B- Regression Analysis by Domain – Page 3

Problem-Solving Development- Dep Variable | **Number of observations = 5671**

Logistic Regression | **LR chi2 (11) = 347.96**

Prob > chi2 =0.0000

Log likelihood = -475.11918 | **Pseudo R2 =0.2680**

Indep Var	Odds Ratio	Standard Error	z	P>|z|	[95% Conf.	Interval]
Stress	1.092726	.2974402	0.33	0.745	.6409349	1.862981
Sex	1.138708	.2264288	0.65	0.514	.7711759	1.681401
White	1.698562	.8109409	1.11	0.267	.666337	4.329809
Black	1.54008	.7715332	0.86	0.389	.5769224	4.111207
Other	1	(omitted)				
Caregiver	.6232725	.1910295	-1.54	0.123	.3418137	1.136492
Target/Alt	.6850306	.1714801	-1.51	0.131	.4194046	1.118889
Dev Age	1.003629	.017828	0.20	0.838	.9692881	1.039187
Gross Mtr	3.497651	1.007421	4.35	0.000	1.988872	6.151006
Fine Motor	8.9027	2.49652	7.80	0.000	5.138371	15.42475
Communic	5.159547	1.731865	4.89	0.000	2.672363	9.96157
Pers-Soc	10.17927	2.860881	8.26	0.000	5.867953	17.65821
_cons	.0136214	.0076417	-7.66	0.000	.0045362	.0409029

Appendix C- Correlation Matrix

Obs=5671	Record ID	Sex	White	Black	Other	Mother	Target
Record ID	1.0000						
Sex	0.0071	1.0000					
White	-0.0090	-0.0035	1.0000				
Black	0.0004	0.0084	-0.8222	1.0000			
Other	0.0147	-0.0075	-0.3986	-0.1942	1.0000		
Mother	0.0075	-0.0162	-0.0921	0.0810	0.0283	1.0000	
Elig. Criteria	0.0187	-0.0022	-0.1181	0.1094	0.0273	0.4242	1.0000
Stress	0.0141	-0.0066	-0.0072	-0.0097	0.0281	0.0084	-0.0289
Dev. Age	-0.0175	-0.0245	0.0848	-0.0698	-0.0336	-0.2182	-0.4945
Gross Motor	0.0122	-0.0217	0.0396	-0.0197	-0.0365	-0.0147	0.0100
Fine Motor	0.0055	-0.0110	0.0086	-0.0023	-0.0111	-0.0045	-0.0385
Pers-Social	0.0249	-0.0120	0.0228	-0.0092	-0.0244	-0.0267	-0.0470
Communication	-0.0069	-0.0246	0.0465	-0.0309	-0.0303	-0.0220	-0.0761
Prob- Solve	-0.0049	0.0006	0.0316	-0.0164	-0.0281	-0.0417	-0.0594

	Stress	Dev. Age	Gross Motor	Fine Motor	Pers-Social	Communication	Prob-Solve
Stress	1.0000						
Dev. Age	0.0574	1.0000					
Gross Motor	0.0274	-0.0418	1.0000			0.1061	
Fine Motor	0.0327	0.0454	0.1902	1.0000		0.0195	
Pers-Soc	0.0081	0.0291	0.2467	0.2524	1.0000	0.2623	0.3520
Communication	0.0129	0.0925				1.0000	
Prob-Solve	0.0114	0.0432	0.2005	0.3044		0.2469	1.0000